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Regional Seminar and Study Tour
on Water Resources Development
in Arid Zones.

Tashkent, USSR, 12 June - 3 July 1981

REPORT OF THE REGIONAL SEMINAR AND STUDY TOUR ON WATER RESOURCES DEVELOPMENT IN ARID ZONES

TASHKENT (USSR), 12 JUNE - 3 JULY 1981

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INTRODUCTION

The project entitled "Seminar and Study Tour on Problems of Water Resources Development in Arid Zones" was initiated under the ECA/USSR Government technical co-operation arrangement and was prepared by the United Nations Economic Commission for Africa and the State Committee of the USSR for External Economic Relations.

The purpose of the project was to give African specialists an insight into water resources development and essential theoretical knowledge of applied methods and techniques, machinery and equipment used in the exploration, exploitation, conservation and utilization of water resources in arid areas. Further, the Seminar and Study Tour was intended to familiarize participants with organizational structures and managerial and research aspects for the development of water resources that can be adapted to the needs of arid areas in Africa.

The United Nations expresses its deep appreciation to the Government and people of the USSR for hosting the Seminar, for arranging the necessary facilities and for the hospitality provided.

1. The Seminar and Study Tour on Problems of Water Resources Development in Arid Zones organized for water specialists of African countries with aridity problems was held from 12 June to 3 July 1981.

2. The Seminar was held in Tashkent from 12 to 19 June 1981 and was followed by a Study Tour from 20 June to 3 July 1981, which included visits to water resources development areas in different basins as well as cultural sites in the Soviet Republic of Uzbekistan.

PARTICIPATION

3. Representatives of the following States members of ECA took part in the Seminar and Study Tour: Benin, the Central African Republic, Chad, Egypt, Ethiopia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, the Libyan Arab Jamahiriya, Madagascar, Mali, Morocco, Senegal, Tunisia, Togo, Uganda, the United Republic of Cameroon, the United Republic of Tanzania, Zambia and Zimbabwe.

4. At the opening ceremony Mr. Khasanov, Co-Director of the Seminar, welcomed participants and invited Mr. Tulyaganov, Minister of Geology of Uzbekistan, to declare the Seminar open.

OPENING OF THE SEMINAR

5. Participants were welcomed by Mr. Tulyaganov, Minister of Geology of Uzbekistan. He said that water resources development was the basis for economic and social progress and called for concerted efforts to be made on the part of everyone. His organization, which had prepared the Seminar, carried out various water resources development activities including hydrological, geological and environmental aspects, and he expressed the hope that the experience gained in the Uzbek Soviet Socialist Republic would be useful to the participants in the Seminar and Study Tour. He stated that the gathering of African water experts in Tashkent was considered an honour for the Republic of Uzbekistan and wished the participants success and a happy stay.

6. In declaring the Seminar open, he stated that Mr. Khasanov, Director-General of the Hydrogeological Institute of Tashkent/Uzbekistan, would serve as Co-Director of the Seminar on behalf of USSR.

7. On behalf of the Executive Secretary of the United Nations Economic Commission for Africa, Mr. H.O. Hoffmann, Chief of the Water Resources Unit of the Division of Natural Resources of ECA, welcomed participants in the Seminar and conveyed the thanks of the Executive Secretary of the Commission to the Government of the Soviet Union for hosting the Seminar and for making the necessary arrangements.

8. He made reference to the recommendations of the United Nations Water Conference and the Lagos Plan of Action and stated that the present Seminar would make an input towards the realization of those recommendations. He mentioned the problems of drought, desertification and food shortage and stressed the importance of integrated water resources development with a view to promoting the socio-economic development of the African region.

9. The basic aim of the Seminar and Study Tour was to give water resources development experts of the African region an opportunity to gain ideas from the reservoir of Soviet experience in the development and management of water resources.

10. He joined the Minister in hoping that the Seminar would promote mutual understanding between African experts and others and contribute to enhancing of international co-operation, with a view to enabling the African countries to fulfill their water resources development objectives.

11. Mr. Kusnetsov, Director of VNIIZARUBEZHGEOLOGIA, welcomed participants and stated that the Seminar would help to widen the outlook of the participants. Tashkent was important in that it fell in an arid area and as the centre for scientific research, and it was a most appropriate location for the Seminar. Further, visits to various water development sites would acquaint participants with the experience of USSR. He expressed the hope that the Seminar, in its own way, would promote water resources development and wished it success.

ORGANIZATION OF THE SEMINAR

12. A large number of papers dealing with various subjects of water resources development in Uzbekistan had been prepared by experts of the Soviet Union for the Seminar. Some participants also presented situation reports on water resources development in their respective countries.

13. The Seminar lasted for eight days, during which lectures were delivered by the authors or their representatives. Each lecture was followed by a discussion which focussed on the topic. The discussions were mainly geared to reflect possible applications to the African situation.

REVIEW OF PAPERS AND SUMMARY OF DISCUSSIONS

(i) Groundwater resources of the Uzbek SSR and their role in the national economy

14. It was pointed out that Uzbekistan possessed considerable resources of fresh and slightly saline groundwater which had been utilized to enhance the national economy.

15. The paper highlighted the formation and availability of groundwater in mountainous regions and low lying arid areas as well as the hydrogeological, hydrodynamic, quality and quantity aspects of surface and groundwater resources.

16. Many arid areas lacked surface water and groundwater was used mainly for economic and social activities such as water for drinking, irrigation, cattle breeding and industrial uses.

17. During the discussion which followed, a number of questions pertaining to drinking water supplies for nomadic populations living in water deficient areas and those towns where only water of inferior quality was available was raised. Other questions related to the problems of using poor quality water for agricultural and industrial purposes as well as to production costs.

18. In response, the speaker pointed out that with regard to the former question, good quality water should be reserved as a matter of priority for domestic uses and under special circumstances nomadic people were supplied with water carried in tankers. Concerning the latter question, industries had their own plans to treat water for their needs, whereas a mixture of slightly saline water with fresh water was used to satisfy the demand for agricultural purposes.

(ii) Fresh underground water in Africa

19. In presenting the paper, the lecturer pointed out that groundwater availability and distribution was uneven because of different hydrological and hydrogeological factors within the various parts of the African region. The largest resources of groundwater were to be found in the equatorial part of the continent lying between 10^{o}N and 10^{o}S, gradually decreasing and reaching the minimum value in the Sahara in the north and in the Namibia and Kalahari deserts in the south. Note was also taken of the considerable quantity of confined water in the Nubian sandstones south of the Sahara. Because of the depth, the water was difficult to extract. Further, the paper dealt with various hydrogeological classifications of the African continent and in general pointed out that over half of the continent was poorly provided with fresh underground water. It was recommended that a more detailed investigation should be made of the underground water resources of Africa.

20. Participants were informed that the hydrogeological map of Africa to a scale of 1:2,500,000 was under preparation in the USSR using material published until 1978. The map would be useful for subregional and regional planning purposes.

21. During the discussion, a remark was made on the importance of the problem of sea water intrusion in the coastal regions of the African continent resulting in changes in hydrogeological parameters. Another point mentioned related to the need to exploit the immense underground water in the Nubian sandstone. The participant from Morocco pointed out that his country has prepared a detailed hydrogeological map to scale of 1:1,500,000 and published it four years ago.

(iii) Organization of water and land development in Uzbekistan

22. The report dealt with the historical background of land and water resources development in central Asia and the Republic of Uzbekistan and pointed out that the latter had very fertile soils which held great promise for irrigation. A lot of research had been carried out in the area of land reclamation and irrigation. Institutional arrangements had been developed to look after rational land/water resources management in the region. The achievements in the area of irrigation, infrastructure, settlement schemes and agro-industrial complexes through massive involvement of population had contributed to the attainment of a very high level of socio-economic progress. Huge water works and expansive irrigation with heavy investment had been accomplished through proper land and water resources management supported by necessary research findings.

(iv) A method for the exploration and valuation of commercial reserves for basic types of groundwater deposits in arid zones of the USSR

23. In making his presentation, the author elaborated the sequence of steps required during the exploration work for groundwater resources. The search started with preliminary identification of promising water bearing horizons. That stage had to be followed by detailed exploration of economically exploitable deposits. He then explained about the various types of groundwater reserves and the related technical, hydrodynamic, hydrogeologic and other aspects that needed to be observed during exploitation. He also called the attention of participants to the need to predict natural and artificial recharges.

24. During the ensuing discussion, it was noted that prospection for groundwater had to be undertaken by teams of experts stage by stage with a view to ensuring effective work. Replenishment or recharge was important in avoiding depletion of wells. During the exchange of views, it was understood that water yield from fissured rocks was restricted by the natural formation and could be used only in areas with few inhabitants.

Further the need for sanitary investigation was important in order to avoid deterioration and contamination of water wells where it was suspected that infiltration of industrial wastes and other contaminants could affect the quality of the water.

(v) A method of conducting experiments to determine hydrogeological parameters

25. The paper highlighted the scientific approach to determining hydrodynamic properties and their relationships to the calculation, exploitation and development of underground water resources. It dwelt on the practical and empirical approaches for determining ground and surface water motion and their interaction. It showed how pumping tests for various purposes should be conducted considering various conditions in terms of location, the influence of wells and duration of pumping.

(vi) Prospection and exploration of thermomineral groundwater in the arid zone of the USSR

26. In introducing this paper, the lecturer explained that thermomineral waters were those containing a high concentration of minerals and gases and with such physcial properties as radioactivity, high temperature, acidity and alkalinity, which because of their properties, could be utilized for energy production for heating dwellings, for therapy and for bottled mineral water depending on their special characteristics. It was also stated that thermomineral waters occured under confined and free conditions and had various hydrodynamic and hydrochemical properties.

27. Participants were informed that the exploration of thermomineral groundwater consisted of a series of investigations such as preliminary exploration and detailed exploration in which a complex of techniques and new equipment were used. The investigation also included formation sampling and water sampling to determine the water quality.

28. During the ensuing discussion, it was noted that thermomineral waters were treated industrially by applying dry vapour and condensor techniques.

(vii) Local water of the desert and its use (Case study of Kara-Kums)

29. The paper dealt with the presence of fresh groundwater floating over water with high salinity which was known as a "water lense" because of the form in which it occurred. It was pointed out that various kinds of fresh water lenses existed under different conditions. Enormous research had been carried out in the Kara-Kums desert in investigating fresh underground water. Through studies, it had been possible to develop a method of withdrawing water from freshwater lenses without affecting its quality. A successful search for additional sources of fresh and low salinity water could be conducted utilizing intermittent surface flow and artificial recharge or takyr flow.

30. During the subsequent discussion, participants were informed that fresh groundwater could be formed under special conditions. As the topic was a point of interest to arid zones, the host organization of the Seminar was requested to make available publications on the subject in English and French. Efforts would be made to meet the request of the participants.

(viii) Experience of desert pasture watering

31. Background information was given on the peculiarities of pasture development and cattle breeding in the Kara-Kums desert of Uzbekistan. General principles of the design and construction of pasture water systems, watering methods, water supply systems as well as animal husbandry programmes implemented in arid regions were presented. Grazing and pasture watering for sheep and cattle breeding in the region had been successfully undertaken in the area as a result of proper surveys and rational management of land and water resources. Well organized institutional set ups had been instrumental in the proper management and development of the region. Following preliminary studies, land was improved and a network of properly spaced wells for watering pasture land was implemented. In that regard, various types of well construction and water catchment installations were outlined.

32. During the subsequent exchange of information, participants were informed that organizational arrangements and financial allocations were policy issues for decision by individual States. Advice was sought regarding the experience of the speaker in relation to the pasture land development which required interdisciplinary/interorganizational involvement resulting in a duplication

of efforts. The speaker stated that in the Soviet Republic of Uzbekistan, his office was charged with the responsibility for hydrological work and when the co-operation of other organizations was deemed necessary in water management activities, such as pasture land development, expert support was secured from other organizations for carrying out specific assignments; through such working arrangements, overlap and duplication of efforts had been avoided completely. It was noted that, while that approach was feasible in Uzbekistan, the approach in other countries should be in line with each country's peculiar circumstances.

33. The participants were also informed that special care should be taken to protect the environment.

(ix) Application of landscape-indication and remote-sensing techniques to hydrogeological and geological engineering studies in arid zone

34. In presenting his paper, the lecturer stated that landscape-indication and remote-sensing techniques had been usefully applied in hydrogeological studies. He pointed out that the result depended on the interpretation obtained from the efforts of multidisciplinary experts. The methods were costly although quick and did completely replace conventional methods. However, they provided good results when used in combination with other techniques. Landscape-indication and remote-sensing techniques had been used to determine groundwater parameters and movements and the impact of man's activity on the environment. Those methods had also been usefully applied to various development activities. The author emphasized that sophisticated equipment such as opto-electronic transformers, computers, etc. were used for interpretation purposes.

35. During the subsequent discussion, it was pointed out that speed of data acquisition coupled with the continuous process of getting additional information were added advantages of this technique. Further it was emphasized that better and reliable data could be obtained for shallow depths.

36. One participant inquired if hydrogeological and geological interpretation could be carried out for his country. The response was that, in such cases, agreement at the governmental level would be necessary.

(x) Geophysical applications in the search for and exploration of groundwater in central Asia

37. A presentation was made on the various methods applied in the search for and exploration of groundwater in central Asia for hydrogeological and engineering-geological studies leading to effective and successful exploitation of sub-surface waters. The methods applied were among others, vertical electrical sounding (VES), circular vertical electrical sounding (CVES), combined electrical profiling, radio-frequency, seismic refraction, radioactive and magnetic survey. Those methods provided information on hydrogeological and geological parameters, water temperature, hydrodynamic characteristics and qualitative and quantitative information on groundwater. The choice of the method to be applied had to be decided by experts on the basis of prevailing conditions.

38. During the discussion, participants were informed of the latitude for precision with certain methods and were given the possible margin of permissible error. Maximum depth for the application of CVES method depending on desired aims as well as the magnitude of application for seismic methods were discussed.

(xi) Geophysical methods in prospecting and exploration for groundwater in central Kyzl-Kum

39. In presenting his paper, the lecturer elaborated the geophysical methods applied in prospecting and exploring groundwater in central Kyzl-kum. The study dealt with physical properties of rocks, interpretation of geophysical data, indentification and prospecting of underground water formation and selection of promising areas for more detailed exploration. The geophysical method, supplemented by other techniques, proved to be most effective for mapping fractured and karst stones in the Paleozoic basement; for identifying the lithology; for estimating depth; and for evaluating the amount of water in the region.

40. During the discussion, participants were informed about the characteristics of the region and the approaches adopted for conducting groundwater exploration. Further, they were enlightened on the possible depth limitation for VES, and on the advantages of expensive and complex geophysical methods over cheaper radiometric and geochemical surveys in non-complicated conditions.

(xii) Exogenic geological processes and the search for water resources in fold belts

41. Before introducing the paper, a demonstration film on exogenic geological processes on landslides, rock faults, silt, ravine, erosion, karst and sub-surface erosion was shown. The film demonstrated a laboratory-model and field condition studies in relation to slide occurrence. The paper then showed that gradient with a combination of permeable soils superimposed over impermeable tilted rockbeds created a suitable conditions for slide occurrences. Inundation due to weakened zones caused mass movement of mudflows resulting in heavy destruction. A number of such incidences had occured in the central Asian mountain regions. To overcome such occurrences, protective measures such as the construction of protection dams had been taken.

42. During the discussion, participants were informed that hydrocarbonate chemicals produced landslide occurrences. They were also informed about preventive measures and protective works to avoid landslides.

(xiii) An outline of the regional valuation of groundwater reserves in the arid zones of USSR

43. It was reported that the conjunctive use of surface and groundwater had acquired great importance for the development of irrigated agriculture and other uses in the arid zones of the USSR. The speaker said that, from his experience, the interaction between surface and groundwater required a great deal of scrutiny to avoid errors prejudicial to irrigation systems. In that respect, he emphasized the importance of making an appraisal and evaluation of the available groundwater and surface water at the local and regional levels for purposes of drinking water supply, irrigation and other activities. It was also important to conduct hydrodynamic and water balance studies and observe the relationship between withdrawal from groundwater and its impact on surface water flow.

44. One participant sought amplification as to the means of maintaining groundwater equilibrium and was informed that that could be done by studying hydraulic characteristics and by undertaking artificial replenishment. Other questions raised related to difficulties faced in interorganizational activities in the field of the development of common acquifers and also with regard to problems related to the joint development of common river basins. In that regard, participants were informed of the experiences and the approaches that had been effectively applied in the Soviet Union.

(xiv) The formation of fresh and slightly brackish groundwaters in central Asian deserts and their application

45. The speaker presented the geographical boundaries of the central Asian deserts which were characterized by mountain ranges and depressions including the genesis of artesian basins. He informed the participants of the process that took place during the formation of groundwater under various hydrogeological regimes. He further made reference to the impact of evaporation and precipitation in affecting the groundwater, often fresh and slightly brackish water that was used for drinking, irrigation and pasture development. An explanation was also given about sub-sandy water lense development and its relationship to geomorphological complexes and general geological and orographic conditions. He explained about the hydrodynamic mechnisms of artesian basins as well as the mineral content of the water lenses that were discovered in the basin.

46. During the discussion that followed, views were exchanged on the genesis of lense waters and on the methods used in the determination of their origin.

(xv) Hydrogeochemistry of intermountain depressions of arid zones (Case study of the Golodnaya steppe)

47. In introducing the paper on the hydrochemistry of the Golodnaya steppe, the lecturer underscored the need for the consideration of evaporation and atmospheric precipitation in terms of their effect on the chemical composition of groundwater. It was pointed out that groundwater in irrigated areas acquired its mineral contents from agro-chemical and physico-geographical influences. A study conducted on water quality in relation to chemical content was presented. The objective of that study was to determine the rational utilization of mineralized waters in conjuction with available fresh water for the development of irrigation, cattle breeding, industrial use and drinking water supplies.

48. During the discussion, participants were informed that further experimentats and studies were being carried out. It was pointed out that different factors influenced mineralization of groundwater depending on the genesis and the condition of its formation.

(xvi) Problem of using mineralized waters

49. The lecturer brought out the fact that available fresh water resources in the world made up one third of the mineralized water. Various feasible methods of demineralization existed and nuclear hydroelectric stations had been found economically sound for desalinization of large quantities of water.

For industries whose technological operations permitted, mineralized water had been successfully used. Through the application of proved methods, very encouraging results had been obtained by using mineralized water for irrigation purposes. In that regard, many examples were cited on irrigation schemes where good yields had been obtained. The presented figures on the acceptable limits of mineral content with which good yields were obtained for various types of crops, fruit trees and fodder. Where mineralized water had to be used for irrigation purposes, special care must be taken. Mention was also made of salt tolerant vegetables as well as the application of mineralized waters for soil leaching.

50. Following the presentation, technical views were exchanged on the negative impact on plant growth of using highly mineralized water for irrigation; effective methods of avoiding brine burning; and the application of the drop irrigation method in USSR.

(xvii) Mineral water in Uzbekistan

51. The paper pointed out that there were various types of mineral waters depending on the geological and hydrogeological conditions of the region. Depending on the origin and composition, mineral waters had curative properties and were used for drinking as bottled waters.

52. During the subsequent discussion, participants were informed that the relationship between radon mineral concentration and tectonic movement, termed "hydro-geoseismicity", had been established.

(xviii) Experience in groundwater prospecting and exploration in USSR

53. A detailed presentation regarding the experience gained in prospecting for and exploration of groundwater in the USSR was made. Participants were informed about the successive steps that had to be followed during the investigation. Stage-by-stage exploration consisting of prospecting, preliminary exploration and detailed exploration would ultimately help in acquiring necessary data and reducing expenses during exploitation. Further, depending on the situation, some steps could either be avoided or combined with other exploratory methods. In that regard, note was taken of the successful results obtained in USSR. Participants were also informed of the occurrences of different types of groundwater under different hydrogeologic conditions.

54. During the discussion that followed, views were exchanged on inter-organizational co-operation for groundwater investigations; on the composition of the study team; on the method of determining the number of wells to be drilled; and on the method for replenishment/recharge of wells.

(xix) Estimation of commercial groundwater storage by the method of simulation on analogue computers

55. The lecturer informed participants that analogue computers were used to simulate and determine the hydrogeologic characteristics of water bearing strata to make an appraisal for economic exploitation of groundwater. The method of analogue computers had a number of advantages over others in that it increased the coeficcient of accuracy and also allowed the determination of necessary parameters which by other methods could be determined only with considerable error. A demonstration was made to explain the procedure for making the study of various parameters.

56. In the discussion that followed, it was learnt that the method was used in areas where hydrodynamic characteristics were governed by the Darcy Law. Further it was pointed out that the method was used to deduce quantitative estimates of underground water filtration with different rates of mineralization and industrial effluents. The method was not restricted by linear dependencies and saved time during investigation.

(xx) Computerized numerical methods of commercial groundwater reserves evaluation

57. In reviewing the paper, it was pointed out that regional evaluation of groundwater reserves under complicated hydrogeological conditions could be achieved rationally through a study of mathematical models and utilization of modern analogue and digital computers. Such models were built to typify the the hydrogeologic and geologic conditions of a region taking into account the most significant links and parameters. Field data and analytical description of hydrogeologic conditions served as a foundation for selecting an appropriate mathematical model which described the motion of groundwater in an aquifer.

58. The reliability of the results obtained from such modelling depended upon the completeness and accuracy of data that were taken to represent the region in question. Further, computerized numerical simulation for groundwater reserves had not yet found wide application. While a number of positive aspects of model studies were enumerated, those models had their own shortcomings as well.

59. Ideas were exchanged on the frequency of fitting data to obtain optimum results (vis-a-vis costs) to get maximum efficiency of the machine as well as the language that was to be used.

(xxi) Methods of determining infiltration, recharge and evaporation of groundwaters in irrigated areas used for water-balance calculations and regional appraisal of groundwater resources

60. The lecturer explained that, in making a study of groundwater recharge and in determining groundwater infiltration, hydrodynamic, experimental and simulation methods were used. Each of the methods was elaborated and supported by detailed technical explanations about the scientific approach for conducting the studies. Lysometric investigation was one of the newly developed techniques. A demonstration was made to explain various types of instrument and their operation.

61. In addition, it was pointed out that, in making infiltration studies, consideration should be given to the soil composition in the zone of aeration, active soil covers, mineralization and lithological aspects.

62. An exchange of views took place in relation to various experiences and difficulties encountered by the different countries regarding the subject of evaporation and evapotranspiration. Participants requested the lecturer for the latest literature which amongst other topics embraced the subject of evaporation, evapotranspiration and groundwater recharges. The lecturer responded positively to the request.

(xxii) A study of artificial replenishment of commercial groundwater reserves in Uzbek Republic

63. In discussing the paper, the lecturer said that the science of artificial replenishment of groundwater was quite a recent development. A study conducted to determine the basic characteristics of an area on the basis of selected parameters had given very encouraging results. Among others, some parameters that needed to be considered were: thickness of aquifer, infiltration rate, aquifer boundary, groundwater level and duration of recharge. The balance of dynamic and hydraulic behaviours should also be studied.

64. Artificial replenishment of groundwater reserves had recently found a wide application as a means of controlling water resources (surface and ground) and improving the rational utilization of land and water resources management. Further, that method permitted the exploitation of reserves by increasing the groundwater capacity and controlling water pollution.

65. To overcome the problems of water management in mountain regions where groundwater reservoirs were to be used, recharge studies could be made by means of analogue simulation or digital modelling.

66. In alluvial plains the potential of artificial replenishment was appraised by studying hydrogeologic, geologic and technical conditions in the areas that were affected by induced surface water infiltration.

67. The lecturer gave an elaborate explanation of the various methods in which artificial recharge took place under different topographic, geologic and hydrogeologic conditions and pointed out the interplay between irrigation water and groundwater.

68. During the discussion that followed, the precautions to be taken in artificial replenishment particularly with regard to the water and soil quality aspects was brought to the attention of the participants.

(xxiii) Instruments and equipment utilized in prospecting for groundwater

69. The paper elaborated on prospecting for thermal, industrial and mineral waters and recommended that studies of the underground water regime, its balance and protection against depletion and contamination should be made. Further, the need for data on exogenic processes of regularities of groundwater formation, as well as in oil and gas-bearing areas for appraisal of hydrogeological and engineering-geological conditions was emphasized.

70. The participants were informed about the various types of equipment used such as well drilling machines and drilling bits, pumps, casings and filters, bailing equipment (airlifting deep well pumps) and logging equipment as well as the neutron moisture/chlorinometer (instrument to determine the volumetric moisture and chlorine content in an aeration zone). The choice of instrument depended on the type of locality to be investigated.

71. In the course of the discussion that followed, information was given to participants on experiences of USSR regarding the use of the different machines and the difficulties encountered during drilling in various geological formations.

(xxiv) Methods of prognosis and standardization of pollution of surface water sources

72. It was pointed out that quality of water was affected by pollution from various sources such as domestic (sewered and non-sewered), industrial effluents, atmospheric precipitation, drainage and irrigation. Water protection should be taken to control the quality of water. The maximum permissible concentration of harmful impurities should be determined to ensure that water was fit for domestic consumption, fisheries, agriculture and industrial purposes. An elaborate demonstration was also made on mathematical approaches to determining maximum permissible concentration of pollutants. The need for forecasting the quality of water was essential.

73. Participants were informed that in USSR various organizations concerned with water quality for different uses were involved in controlling and monitoring activities.

(xxv) Methods of research and technique of prediction of groundwater pollution for substantiation of water protection measures

74. The author gave an account of underground water pollution, prevention and localization. Man caused pollution and water was the main carrier of pollutants. Further, he emphasized the need for stage-by-stage water quality monitoring and pointed out that observation boreholes were used as control points. The author then elaborated on how forecasts of pollution were made on the basis of model studies. In that regard, the estimation of parameters was characterized by the groundwater regime. He described the methods of prediction, the study of the migration process and presented a mathematical approach that was followed for pollution prevention.

75. In the ensuing discussion, participants were informed that the determination of groundwater flow was important in controlling pollution. They were also informed of the measures which had to be taken for controlling pollution.

(xxvi) The influence of irrigation and drainage on man's health

76. The speaker appraised of the environmental change which occured as a result of man's activities. She went on to say that, amongst other activities, irrigated agriculture had contributed much towards changing the environment.

In that regard, fertilizers and pesticides caused deterioration in the quality of water, making it hazardous to human and animal life. Such water also effected the chemical composition of the soil and underground water reserves. Special mention was made of the negative effects of nitrates, diodrine, phosphorous and carbonate substances which had deleterious effects on human health.

77. As a means of reducing such negative effects, care should be taken to use chemical substances that had a low degree of toxicity and those which decomposed easily. It was also recommended that norms and standards of permissible limits should be observed.

78. During the discussion, participants were informed of the measures to be taken to protect the environment. In that respect, the cautious application of fertilizers was emphasized.

(xxvii) Impact of the central Asian groundwater regime on secondary soil salinization

79. The author stated that natural and man-made factors brought about changes in the balance of salt content in soils. He cited precipitation, evaporation and evapotranspiration as the first case and the direct consequences of irrigation for the second. The peculiarities of the groundwater regime in central Asia was considered in the terms of stable and unstable conditions in their relations to various morpho-genetic types of territories according to the patterns of underground outflow and period of irrigation. The interplay between surface water and groundwater had a very important role in changing the salinity concentration of soils in the aeration zone.

80. As a result of intensive groundwater recharge by direct infiltration of irrigation water (where inadequate sub-surface outflow conditions prevailed) the groundwater table approached the surface and recharge was balanced by total evaporation causing increased salinity in groundwater and resulting in secondary soil salinization. As remedy for such type of deterioration, artificial drainage was recommended.

81. To overcome salinity problems, scientifically proven approaches to irregularities in groundwater quality should be observed and forecasts should be made for the natural groundwater regime. In that respect, a number of investigations regarding salinity concentration in soils owing to the effect of irrigation activities had been undertaken.

82. During the exchange of views that followed, participants were informed that in Uzbekistan, irrigation was carried out on the basis of scientific research findings and recommendations and the problem of salinity was not expected over the coming few decades.

(xxviii) Application of vertical drainage on irrigated land in Uzbekistan

83. In making his presentation, the speaker pointed out that in irrigated areas, drainage conditions greatly distorted the natural equilibrium in the balance of the groundwater table. In order to avoid that problem and to overcome the consequences of salinization a means of suitable drainage had to be provided.

84. In waterlogged areas, vertical drainage systems had been developed. A series of tests to overcome the various problems faced were elaborated by the lecturer. In that respect, he explained the development of a special drilling operation for 1 m. diameter hole, a method which was being successfully applied. Water taken out of the drainage system could either be directly used again for irrigation or, when its salt content was high after diluting with freshwater.

85. The presentation was followed by discussions and a number of doubts were clarified. Participants were informed that a more effective and less costly combined drainage system using the overflow principle had been developed to overcome the problem of waterlogged lands.

(xxix) Methods of hydrogeological and engineering-geological investigation for the purposes of irrigation and reclamation in arid zones

86. The lecturer explained the need for using comprehensive geological, geomorphological, hydrogeological, engineering geological landscape indicators, air-borne and spacecraft pictures as well as mathematical modelling methods for qualitative and quantitative appraisal of groundwater at a regional level. Hydrogeological appraisal parameters as well as other factors had to be considered for a study of water resources in relation to their use for irrigation.

87. The data obtained from the different sources were analysed by specialists and used for the preparation of groundwater maps, maps showing chemical composition, prognostic maps showing change of groundwater, maps giving the infiltration parameter of soils, prognostic maps of hydrogeological reclamation zoning and prognostic maps on engineering geology.

88. In the discussion that followed, many questions were asked by participants about the process of investigation that might be recommended and cost indications for irrigation schemes.

(xxx) Hydrogeological-meliorative conditions in central Asian regions under irrigation, construction and hydrogeological and engineering-geological investigations necessary for irrigation

89. The lecturer outlined the dry climatic and high evaporation conditions of the central Asian region. He elaborated on the various types of soils and their suitability for agricultural development. A series of studies were made on required drainage systems in order to avoid negative post-development effects.

90. Comprehensive hydrogeologic and engineering-geologic studies had to be made. Among others, studies on analogous land already irrigated were useful to provide comparative evaluation. Further, forecasts had to be made in relation to local conditions as well as on a regional scale beyond the limits of the irrigated area. In describing the sequence of studies, three stages were identified namely:

(a) Scheme: To consider complex economic water problems pertaining to a region, newly developed land should be studied to determine the economic and technical feasibility of a project;

(b) Technical project: This involves all areas of land to be irrigated and details had to be worked out to select optimal types of irrigation;

(c) Working drawing: To provide the design of the project and the day-to-day construction activities.

91. In the discussion which followed, views were exchanged regarding cost and time factors, probable degree of success of projects and the main parameters for consideration in irrigation projects.

(xxxi) Water resources of the Aral Sea basin and their utilization prospects

92. The paper dealt with the water resources of the Aral Sea basin as well as its surface and groundwater resources potentials. It dwelt on the approaches for regulating and using the water resources in the basin. Emphasis was laid on

the problems of land reclamation, optimization of irrigation development and utilization of mineralized water. The paper enumerated the indices of economic effectiveness of land and water management in the Aral Sea basin.

COUNTRY PRESENTATIONS

93. Representatives of: Guinea-Bissau, Madagascar, Uganda and the United Republic of Tanzania presented papers on activities related to the drinking water supply sanitation in their respective countries. In their presentations, they discussed various problems encountered. Some problems mentioned consisted of the fluoride content in water sources, lack of basic data and information, shortage of manpower, machinery and spare parts. One participant called for an exchange of knowledge and experience with African countries and sought sympathetic consideration by developed countries, particularly in the area of financial assistance.

94. The participant from the Libyan Arab Jamahiriya outlined his country's project for water supply and pointed out that sea water intrusion, resulting from heavy draw-down of wells, and the sulphur content of groundwater were some of the dominant problems.

95. The presentation by the representative of Morocco was on problems of sand suction and the different measures taken to solve it. He described the well design that was applied to avoid sand intrusion and increase the yield of the well.

VISITS AND STUDY TOURS

Sunday, 14 June 1981

96. A study tour was conducted to the Chirchik River Valley some 200 km. away. Participants were shown a series of cascades, landslides and caves. A water resources development scheme, the Charvak impounding reservoir which was a multipurpose project for irrigation, hydropower generation, flood and mudstream control, was visited. The Khodjikurt hydro-impounding reservoir was also seen. The irrigation of about 150,000 ha. of land hydro-power generation and settlements schemes were mentioned as the main features of the development projects.

Monday, 22 June 1981

97. Mr. Khasanov, Director of the "Uzbekgidrogeologia" Obiedineniye, gave a detailed presentation concerning the tasks and responsibilities of his organization. He also briefed participants on the Tashkent Polytechnique Institute which made provision for training foreign students in the fields of engineering geology, hydrogeology and geochemistry.

98. Three other speakers briefed participants on environmental protection as well as the production and scientific activities of the organization.

99. With regard to environmental protection, participants were informed of the protection and preservation measures that were taken to restore fauna and flora. Attention was drawn to the fact that special care was taken for the preservation of rare species of animals.

100. Concerning the scientific activities of the corporation, the Institute conducted geological and hydrogeological research, drainage systems, drilling tests, estimates of water reserves, made forecasts and prepared maps and designs for land development and reclamation.

101. In the afternoon of the same day, a visit was made to the hydrogeological laboratory where studies on groundwater movements, quality and availability were being carried out and hydrogeological maps compiled. Participants also visited the analogue computer laboratory for groundwater analysis.

Tuesday, 23 June 1981

102. Participants paid a visit to the Central Asian Scientific Research Institute for Irrigation. They were acquainted with the various activities and scientific work being carried out in the Institute leading to optimal benefits in the proper development of land and water resources. A demonstration film on irrigation development in central Asia and applied irrigation technology in the region was shown. Participants were then shown laboratories where soil and agronomic studies as well as vertical and horizontal drainage studies were being conducted.

103. An explanation was given in reference to a development plan for the Central Asian Republic through water transfer from the Siberian region. The project was a gigantic scheme where a number of post-development impacts had to be studied. To that end, a model study which simulated field conditions was demonstrated to the participants.

Wednesday, 24 June 1981

104. The Mineralogical Museum of the Ministry of Geology of the Uzbek Soviet Socialist Republic was visited where participants were shown various collections of mineral compounds, rocks and models to demonstrate the occurrences of minerals. The Computer Centre of Tashkent where geophysical and seismic data were processed was also visited.

Thursday, 25 June 1981

105. The participants drove south from Tashkent to Golodnaya steppe, crossing the upper portion of the Chirchik Valley. Along the route, both sides of the road were covered with irrigated cotton fields, fruit gardens and settlement sites. Many kilometers of canal constructed for irrigation purposes were seen on the way to the Golodnaya steppe. It was stated that the total area of land irrigated and to be irrigated was about 1.1 million ha. including the area of the Golodnaya steppe, which was 850,000 ha. The following various technical aspects of irrigation and drainage systems were demonstrated during the field visit:

(a) Vertical drainage: Participants observed a number of wells drilled to drain the land by reducing the groundwater table in the upper layer of the soil. This method was meant to demonstrate the technique applied for vertical drainage of land under irrigation;

(b) Pumping station: A visit was made to a large pumping installation designed to lift the water to irrigate 200,000 ha. of land;

(c) Horizontal sub-surface drainage: Participants were shown a mechanized operation of simultaneous digging, pipe laying, filter packing and backfilling for a horizontal drainage operation;

(d) Subsoil irrigation: An illustrative explanation was given about the experimental works which had been carried out for a period of about eight years on subsoil irrigation techniques which had resulted in good crop yields and high performance efficiency;

(e) Surface irrigation: A new system of surface irrigation using reinforced PVC pipes with laterals to be laid on the surface was shown to participants. That method which was at the experimental stage was intended to minimize evaporation lossess and to control operational problems which could be observed on the surface. The system could find good application in arid countries in Africa.

Saturday, 27 June 1981

106. On the morning of Saturday, 27 June, participants flew from Tashkent to Fergana to continue the study tour. Late in the afternoon, they visited the Kuvinsk region, where they were acquainted with a vertical drainage system (wells in operation). It was explained how the operation of the wells was piloted by remote control. Since the quality of water extracted from the drainage system was good, it was used for irrigating the farms.

107. Later, a visit was made to the Kirkidon impounding reservoir, which had been constructed to meet the demand for agricultural water needs to irrigate 112,000 ha. of land in Andizban and Fergana regions. The dam had helped in protecting settlements, canals, highways, railroads and cultivated fields from disasters caused by mudstreams.

Sunday, 28 June 1981

108. From Fergana participants visited the mountainous settlements of Khamzaabad. Participants saw historical places like the museum and the mausoleum of Khakim Khamza Niazii. The Blue Lake, formed as a result of tectonic movement 4 km. uphill of the Khamzaabad settlement, was visited.

Monday, 29 June 1981

109. A visit was made to the diversion weir at the Naryn river, where the Grand Fergana Canal began. That canal was the main structure of the entire irrigation system consisting of three more canals which altogether collected the water from glacier, melted snow and the upstream rivers. The Grand Fergana Canal has a total length of about 250 km. with a discharge capacity of 200 m^3/S and irrigation area of 311,000 ha.

Tuesday, 30 June 1981

110. Participants were flown from Fergana to Samarkand.

Wednesday, 1 July 1981

111. At a distance of 50 km. east of Samarkand, a stop-over was made to show participants the first part of weirs and the water distribution system of the Zararfshan river. A detailed explanation was given on the entire distribution system for irrigation requirements along the river.

112. On the way back to Samarkand, the Central Miankal Canal including all the distribution structures was also visited.

Thursday, 2 July 1981

113. Participants were driven north-west to the Nuratia inter-mountain valley, where the Ergash Djamanbulbul State farm was located 140 km. from Samarkand. The farm occupied about 100,000 ha. of land including 7500 ha. of pasture land.

The area was mainly a cattle and sheep breeding as well as dry farming zone. Previously, water for irrigation and pasture development had been obtained from a system of shallow wells locally known as "karizes". Maintenance of those shallow well systems was time consuming and costly. The karizes were therefore being replaced by drilled production wells. Water being scarce in the area, deep wells remained the main sources of water supply for agricultural development. The water was of high quality, although limited in quantity.

Friday, 3 July 1981

114. In the morning a visit was made to ancient monuments in Samarkand.

ADOPTION OF THE REPORT

115. The report of the Seminar and Study Tour on Water Resources Development in Arid Zones was adopted.

CLOSURE OF THE SEMINAR

116. The Seminar and Study Tour ended on 3 July 1981. At the closing session, a representative of the United Nations Economic Commission for Africa, African water experts and representatives of the Soviet Union gave their final addresses.

117. On behalf of the Ececutive Secretary of the United Nations Economic Commission for Africa, Mr. H. Hoffmann, Director of the Seminar, pointed out that the Seminar and Study Tour had been profitable and, as a result, constructive recommendations had been made. ECA would take all possible steps to meet the recommendations made by the participants. He thanked the Soviet Government for hosting the Seminar and expressed his appreciation to all Soviet individuals and Institutions whose efforts had contributed to the success of the Seminar and Study Tour. He also thanked participants for their attentive participation in the programme.

118. On behalf of the water experts, one participant gave a vote of thanks to the organizers of the Seminar and to the United Nations Economic Commission for Africa. The hosting of the Seminar by USSR was a testimony of goodwill towards the African region and he thanked all individuals associated with the Seminar and field demonstrations. He also expressed appreciation for the hospitality given by the Republic of Uzbekistan. Finally, he wished the Soviet Government success in combating drought and desertification in its arid zones, and invited it to help African countries to overcome the problem of drought.

119. Mr. Khasanov, Co-Director of the Seminar, conveyed good wishes to participants from the Minister of Geology of Uzbekistan Republic and expressed hope for their success in developing the water resources of their countries.

120. He stated that the information gained through the Seminar would be useful to participants and attributed the success of the Seminar to the efforts of all involved. He thanked the ECA secretariat as well as the officials and the associated staff of VNIIZARUBEHGEOLOGIA.

121. Mr. Kuznetsov, Director of VNIIZARUBEHGEOLOGIA, highlighted the main areas which had been covered during the Seminar and pointed out some of its shortcomings. He said that to cover all important aspects would require much more time. Over all, he expressed his satisfaction with the achievement of the objectives of the Seminar. He associated the success of the Seminar with the prominence of the experts and their high calibre.

122. Finally, he thanked all the participants, for their keen interest and the ECA secretariat for its efforts and declared the Seminar closed.

CONCLUSIONS AND RECOMMENDATIONS OF THE SEMINAR
AND STUDY TOUR

- Tashkent was suitably chosen for holding the Seminar. It had well equipped institutions and experienced lecturers to promote water resources development programmes in arid zones.

- The choice of various places for the Study Tour to visit in the Soviet Socialist Republic of Uzbekistan was appropriate and had served the purpose of demonstrating research work, pilot schemes and actual field development projects. During the Seminar, the documents presented by the lecturers of the host country were of a high level and had generated enormous interest on the part of the participants from the African countries.

- While the Seminar and the presentations had been useful and informative, it was recommended that in future, to give a better opportunity to African participants, all documents related to the Seminar and/or abstracts of documents should be sent out in due time, i.e. at least one month prior to the holding of the Seminar.

- Participants expressed the views that they had gained valuable information and experience concerning activities related to water resources development such as prospecting, exploration, utilization and management and, in particular, the replenishment of groundwater for various water development activities and the environmental impact of water resources development including measures to be taken to minimize negative effects.

1. It was therefore recommended that ECA, in collaboration with the Soviet institutions responsible for the Seminar, should spare no efforts to make available to African countries scientific literature and papers dealing with water resources development.

It was also felt that contacts established during the Seminar and Study Tour should be further developed. In that regard, it was recommended that ECA should take all necessary steps to promote close co-operation between the experts of African countries and those of USSR, and also among African experts themselves.

2. It was further recommended that the exchange of scientific missions on water resources development between African countries and USSR should be organized and in particular between corresponding universities and research institutes.

In recognition of the fact that training facilities in USSR had in the past been made available to develop the manpower resources of many African countries, it was recommended that USSR should increase its intake of African experts for fellowships, scholarships and training in the field of water resources development.

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